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Erosion on tropical rain-forest terrain: a re-evaluation in the light of long-term monitoring, aerial photographic evidence and sediment fingerprinting in Borneo

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Rain-forest vegetation is generally considered to be highly protective against erosion, but with disturbance via logging leading to major, but relatively short-lived increases in erosion for a 2-year period until rapid revegetation of slopes has occurred. This paper questions and re-assesses these views using a combination of long-term monitoring, GIS-assisted aerial photograph analysis and multi-proxy sediment fingerprinting in primary rainforest and adjacent terrain that was selectively logged either in 1988-89 or in 1992-93 within the Segama catchment in eastern Sabah, Malaysian Borneo.

In primary forest areas, repeat measurements using the erosion bridge technique over the 20-year period 1990-2010 demonstrate how slopewash rates are significant, but concentrated in extreme events and increasing sharply with slope angle. Continuous monitoring of suspended sediment, coupled with repeat erosion bridge measurement, however, demonstrate that pipe erosion is at least as important even on moderate terrain and landsliding is an important process on steep terrain.

In the selectively logged Baru catchment, a combination of long-term monitoring of suspended sediment and repeat measurements at an erosion bridge network has demonstrated that the erosional impact of logging is longer-term than formerly thought, with a major secondary peak in erosion 5-10 years after logging due to road-linked landslides and the decay of logs in debris dams; analysis of current bed-sediment and floodplain cores using a multi-proxy sediment fingerprinting approach demonstrates that sources of sediment are still different to those in primary forest over 20 years after logging ceased. Sediment fingerprinting at the large catchment scale (focussing on the analysis of lateral bench and floodplain sediment cores compared with upstream tributary sediment inputs), together with GIS-assisted analysis of aerial photographic evidence of spatial differences in landslide occurrence, demonstrates the key importance of terrain steepness and logging practices in influencing erosion rates as a result of logging. Increased landslide frequency is the main process leading to very high erosion rates in areas of steep terrain, but can be avoided if Reduced Impact Logging protocols are followed.

Finally the possible consequences of current and IPCC predicted future climatic change in the region are considered. The key influence is likely to be an increase in the magnitude and frequency of extreme rainstorms. This will lead to a phase of increased landslide frequency not only in terrain covered by regenerating forest following logging and in agricultural plantation land, but also in primary forest areas; such a landslide phase would also lead to major fluvial instability downstream.